

Fear of Math

Ashutosh Jogalekar, 9 August 2021

From 8th grade to 11th grade, I was taught mathematics by a teacher who was a tyrant. A brilliant man who left a lucrative engineering career to teach high school, he clearly was dedicated to teaching the subject. But his dedication took the form of catering to the brightest students in the class and mocking the rest. Since I was not among the brightest students, I was often the object of his ridicule. I was deeply interested in music by this point and sometimes came in late for class because I was held up in music practice; when this happened he used to mercilessly taunt me in front of everyone else and tell me that I should probably drop out of school and start a band. Sometimes he used to refuse me entry to the class. At an age where peer validation means much, this was devastating. Hatred of the man led to hatred of math and I turned into a rebel, not caring about the subject. I liked the abstract aspects of math but just wouldn't do the problems, seeing it as an act of rebellion

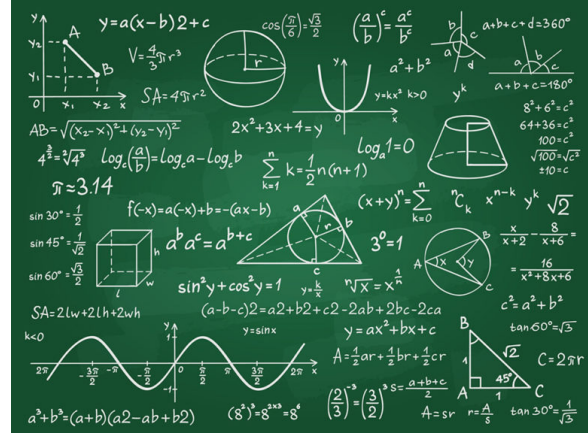


Image: CSUN

The old joke goes that the world can be divided into three kinds of people – those who can count and those who can't. Like many jokes this one has a shred of truth in it because math does seem to impose binary divisions on us. Most of us put up with it because it's useful to us to various extents in our professions, be it accounting, biology or economics. Some of us love it. A select few are blessed with great natural ability and passion for the subject. The rest of us are not just bad at but are often proud of our mathematical deficiency. How often have we come across people or caught ourselves joking that we were always "bad at math"? The result of this attitude – as indicated by any reading of the pandemic news these days for instance – is that we live in a largely mathematically illiterate society which is both bad at and distasteful of numbers and statistics. But it doesn't have to be that way.

My own experience, unfortunate at first but redemptive at the end, is a reminder of not just how useful (and beautiful) math can be but more importantly, how being "bad at math" has everything to do with psychology and almost nothing to do with innate intelligence. Going back to my high school experience, partly because of this teacher, I started doing badly. But what was worse was that some well-meaning family members bought into the failure. My supposed inability at math turned into a family joke, and a cousin used to always ask me "So, what's 7+5?" whenever we met. The worst part was that I bought into the joke myself, not realizing that it would turn into a self-fulfilling prophecy. To this day I frown whenever I see family make fun of a child's supposed inability to pick up on a skill, be it music or math or a sport. It may sound like a joke, but it can breed long-term resentment and underutilization of potential.

Things started improving when I met a teacher in my last year of high school who was kind and patient and who, instead of embracing the one-size-fits-all strategy adopted for the brightest students by the former teacher, actually believed in tailoring different approaches for students with different abilities. This tailored approach is not just important in high school but also in the highest echelons of scientific mentorship; for instance the physicist Hans Bethe who created one of the most successful schools of theoretical physics in the United States was known for pitching the right level of problem

at the right student, saving the hardest problems for superlative students like Freeman Dyson for instance. Especially in mathematics, any teaching strategy that relies on a one-dimensional approach for all students is bound to leave some students floundering and others dissatisfied.

The high school teacher did course-correct my inclination toward math, but the best was yet to come. By the time I got into college I had multiple interests and was not yet sure what I wanted to major in. But by that time, the “I am bad at math” mantra had indeed become a self-fulfilling prophecy, reflected not so much in grades as in a lack of interest. I started believing that because I am “bad at math” I shouldn’t even try. So it came as a surprise when in college I met a very patient teacher who coached students for the math olympiad. He was a superb teacher who exuded passion for the subject and made every effort to carefully explain things multiple ways if students didn’t understand it one way. Purely through accident at this time, I had gotten my hands on a book on topology, a subject that I had become mildly interested in because of its deep connections to geometry; interestingly, while I was rather abysmal at algebra in school, I always did well with geometry because I was good at visualization. When I decided to specialize in chemistry later, these visualization skills came in handy.

Topology was not part of the undergraduate curriculum in college, but the professor offered to help me anyway. The book I had gotten my hands on was “Introduction to Topology and Modern Analysis” by George F. Simmons, a mathematician who taught at various places including Colorado College, Yale and the University of Chicago. Simmons’s book was ideal for solitary study and suited for someone like myself who wanted to start with the basics. It started with the elementary axioms of set theory and analysis but quickly went into advanced territory with vigor and rigor, discussing concepts like completeness, compactness, Banach spaces and the Heine-Borel theorem. The great revelation came when I started studying the book. The first night I opened it I was enthralled. Most importantly, I *understood* it. I stayed up until 3 AM reading it, feeling a math high that I had never felt before. Every week after that, I would make my way through the book and meet the professor. The professor would generously meet with me outside formal office hours and he would patiently explain proofs that I hadn’t understood. I was stupefied since I was supposedly “bad at math” but mostly understood this stuff that was pretty advanced for undergraduates.

The topology book and the professor completely changed my outlook and saved me. I started doing well and tackling advanced topics and started to love math. I also got interested in physics and did well. Most importantly, I *started appreciating the beauty of math*. Over time I found that people interested in mathematics are generally of two kinds, although there’s some overlap: there are those who really enjoy mathematical puzzles and puzzle-like problems, relishing the raw process of problem-solving. Then there are others who simply enjoy the abstract nature of proofs and the connections between different topics: I am definitely part of this second group. In fact, another revelation I had was that most of the high school curriculum needed the students to be good at the former skill and had no appreciation of the latter, thus simply weeding out students like myself who wanted to understand the big picture and see the connections rather than just become adept at problem-solving.

My renewed interest in math took me into the more theoretical parts of physics and chemistry, which is exactly the field I am in now. Statistical and quantum mechanics brought joy to me. Most importantly, my renewed confidence meant that I would no longer simply look away when I encountered a few pages full of equations in a paper or book but would make the effort to understand. And in many cases, understanding is at different levels; especially in the physical sciences it often suffices even when you can understand the math in a semi-quantitative way, appreciating the proportionalities and physical significance of the equations. In the last few years I am again enjoying some pure math, partly thanks to an amazing retired friend who is now deep into differential geometry, topology and calculus.

But I don't want to digress from the bigger lesson that I learnt and which I have tried to communicate to students I have met over the years. This is that being "bad at math" has very little to do with innate intelligence and everything to do with psychology and self-confidence. The vast majority of us can be reasonably good at math if we try, and some of us can be very good. Unfortunately a bad teacher can hobble that self-confidence while a good teacher and self-motivation can restore and inspire it. But the most important thing is to believe in yourself, have confidence and try, and discourage your family from joking around too much. That's why I think parents should *never* allow their kids to believe that they are "bad at X", whether X is math, music or sports. Self-fulfilling prophecies by definition have a way of coming true.